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Communication Between a Vehicle and a Terrestrial  
Communication System

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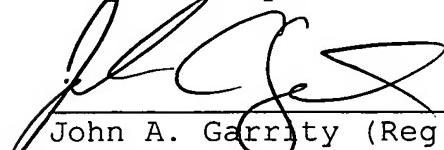
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Applicant(s) claim the benefit of the following prior foreign patent application under 35 U.S.C. §119 for the above-identified U.S. patent application:

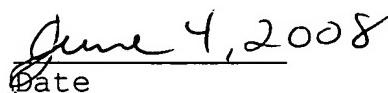
Country: Finland  
Application No.: 20030929  
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Attached is a certified copy of the foreign application from which priority is claimed.

Respectfully submitted,

  
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Title of invention

"Method and arrangements for wireless communication in a vehicle"  
(Menetelmä ja järjestelyjä langattoman tiedonsiirron toteuttamiseksi  
kulkuvalineessa)

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## **Method and arrangements for wireless communication in a vehicle**

### **TECHNICAL FIELD OF THE INVENTION**

The present invention relates to the field of mobile radio communication systems in  
5 cellular wireless networks, and more particularly to mobile communication systems  
using wireless network cells inside a vehicle, such as an aircraft, other airborne ves-  
sel, ship or train while aboard.

### **BACKGROUND OF THE INVENTION**

The use of mobile phones is restricted inside airline carriers due to a possibility that  
10 the transmission of a mobile phone could cause interference problems.

The Federal Communications Commission (FCC), which regulates the use of wire-  
less mobile phones aboard aircrafts while they are in flight, has since 1988 barred  
the use of cellular phones in the air because of their potential to interfere with ter-  
restrial cellular calls. This regulation names only mobile phones operating in the  
15 850 MHz cellular band, but the airlines have the authority to decide about the use of  
any type of mobile phone during flight. The Federal Aviation Administration (FAA)  
recommends for its part that the use of a cellular phone is unauthorized during taxi-  
ing, take-off and landing.

There has raised also some other problems due to relatively high transmitting power  
20 of wireless systems and electromagnetic interference thereof. Anecdotal instances  
suggest that the use of the mobile phone on an aircraft might interfere with the  
navigation equipment and other avionics or communications equipment on the air-  
craft. Another problem is that due to the height of an airborne aircraft the wireless  
network coverage does not cover the mobile phones on an airborne aircraft because  
25 the terrestrial wireless networks are designed for lateral transmission and reception  
of radio frequency signals and for relatively slow moving vehicles and pedestrians.  
One solution for this problem is to provide a base station and thus an internal cell  
inside the aircraft. However, other problems may arise when there exists a wireless  
cell inside an aircraft and at the same time there are available powerful external  
30 wireless cells. There is, for example, a problem to keep all the mobile phones inside  
the aircraft exclusively camped to the cell inside the aircraft.

Although the use of the mobile phone from an aircraft might be possible at some altitudes, it does not operate within the considerations designed and built about call handovers between adjacent terrestrial cells. Due to the high velocity of the airborne aircraft an equally strong RF signal from the mobile phone may be picked up on multiple base stations on the ground and the network is unable to process a normal call handover procedure. This may result malfunction of operation, would drop calls frequently and can actually cause base stations to shut down. This may also jam calls of other users covered by the same terrestrial base stations.

Today wireless communication services for passengers are provided in aircrafts by dedicated phones that are installed at each seat and wired to the central transmitter/receiver in the aircraft. This network of phones operates on its own frequency band which differs from other frequency bands used for avionics. To run this service a service provider must provide base stations on the ground to which RF signals are transferred in the vertical direction i.e. a skyward transmission and reception. To allow smooth handovers in the air these base stations must cover a much larger territory than the base stations of the terrestrial wireless network and antennas must be focussed skywards. Service users must use the dedicated phones provided by the service provider and users having personal mobile phones in the aircraft must keep their equipment switched off.

As more and more people carry and use mobile phones, it may not be justified to maintain areas where their use is prohibited because it increases the tendency for misuse and contravene rules unintentionally or on purpose.

## SUMMARY OF THE INVENTION

In this application the following terms are used. The term "indoor" relates to the objects which are located or used inside the aircraft independent of the location of the aircraft whether being in the air or on the ground. The indoor mobile terminal relates to the wireless mobile terminal equipment that is used inside the aircraft. The indoor mobile terminal is typically a personal terminal equipment carried and occupied by its user (also outside the aircraft). The indoor connection or network relates to the wireless connection or network and to its components that are located or are used inside the aircraft. In the same sense, the term "external" relates to the objects which are located or used outside the aircraft. The external mobile terminal relates to the wireless mobile terminal that is located and is used outside the aircraft. I.e. the same mobile terminal may be the indoor mobile terminal or the external mobile terminal depending on whether it is used inside the aircraft or outside the aircraft.

The external network relates to the wireless network and to its components that are located outside the aircraft. As a clarification it shall be noticed that the indoor networks and external networks are fully capable of communicating with each other.

An object of the invention is to solve the problems related to prior art and thus provide an aircraft profile for wireless communication via a wireless connection or network inside the aircraft and a mobile terminal capable of communicating with a external terrestrial wireless network, in which the mobile terminal can be switched on to be used inside an aircraft without interfering with navigation and other avionics equipment, and without being jammed by operation of unwanted external wireless networks outside the aircraft.

The object of the invention is fulfilled by providing an aircraft profile which adjusts a transmitting parameter of a wireless connection or network and a mobile terminal inside the aircraft to a limit value which is sufficiently high to guarantee acceptable voice and data transmission quality inside the aircraft and which is sufficiently low not to be interfered with external wireless networks. The limit value of the transmitting parameter adjusted by said aircraft profile according to the invention overrules commands given by external wireless networks in relation to the transmitting parameter of indoor mobile terminals.

In accordance with a first aspect of the invention there is provided a method for providing an operational mode of wireless communication between at least one mobile terminal and at least one first network device inside the aircraft, the method comprising steps of: communicating from the mobile terminal information indicating an operational mode that the mobile terminal uses for a wireless connection between the mobile terminal and the first network device inside the aircraft; connecting the mobile terminal via the first network device inside the aircraft to wirelessly communicate with a second network device outside the aircraft, where the wireless connection between the first network device and the second network device uses an operational mode of communication capable of communicating with external wireless networks outside the aircraft; is characterised by: limiting a transmitting power value for a wireless connection between the mobile terminal and the first network device to a limit power value which ensures a quality of service of the connection and does not interfere with external wireless networks; selecting at least one frequency value to establish a wireless connection between the mobile terminal and the first network device which frequency value ensures the least interference with external wireless networks; and configuring the operational mode of communication

in the wireless connection inside the aircraft on the basis of said limit power value and said frequency value.

In accordance with a second aspect of the invention there is provided a system for wirelessly communicating information between a mobile terminal inside an aircraft and a first network device inside an aircraft, the system comprising: at least one mobile terminal for wirelessly communicating with the first network device information indicating an operational mode that is used for a wireless connection between the mobile terminal and the first network device inside the aircraft; at least one first network device for wirelessly connecting the mobile terminal to communicate with the second network device outside the aircraft where the connection between the first network device and the second network device uses an operational mode of wireless communication capable of communicating with external wireless networks outside the aircraft; at least one second network device outside the aircraft for wirelessly communicating with external wireless networks; is characterised in that: the mobile terminal is arranged to limit a transmitting power value for a wireless connection with the first network device to a limit power value based on determined quality of service of the connection and minimum interfere with external wireless networks; the first network device is arranged to limit a transmitting power value for a wireless connection with the mobile terminal to a limit power value which provides at least a determined quality of service of the connection and minimises interference with external wireless networks; the system is arranged to select at least one frequency value to establish a wireless connection with the mobile terminal which frequency value ensures the least interference with external wireless networks; and the system is arranged to configure the operational mode of wireless communication in the wireless connection inside the aircraft on the basis of said limit power value and said frequency value.

In accordance with a third aspect of the invention there is provided a first network device for communicating information via a wireless connection to a mobile terminal inside an aircraft, and for communicating information via wireless connection link to a second network device capable of communicating in external wireless networks outside the aircraft, the first network device comprising: means for transmitting information to the mobile terminal in a wireless network, the information indicating an operational mode that the mobile terminal uses for a wireless connection between the mobile terminal and the first network device; means for connecting the mobile terminal inside the aircraft to wirelessly communicate with a second network device outside the aircraft, where the wireless connection between the first

network device and the second network device uses an operational mode of wireless communication capable of communicating with external wireless networks; is characterised in that the first network device is arranged to: limit a transmitting power value for a wireless connection with the mobile terminal to a limit power value which provides at least a determined quality of service of the connection and does minimises interference with external wireless networks; select at least one frequency value to establish a wireless connection with the mobile terminal which frequency value causes minimum interference with external wireless networks; and configure the operational mode of wireless communication in the wireless connection inside the aircraft on the basis of said limit power value and said frequency value.

The present invention provides an aircraft profile which adjusts a transmitting power of a cellular system and a mobile terminal used inside the aircraft to a limit value that the mobile terminals inside the aircraft camp the indoor cellular network inside the aircraft and do not interfere with external cellular networks. This limit value of transmitting power in the indoor cellular network also reduces possible electromagnetic interference with avionics inside the aircraft, because the transmitted power levels are low. The frequency band used by the indoor cellular network can be determined by the service provider (or operator) independent of frequency bands allocated by the countries in whose airspace the aircraft is flying or to which the aircraft is landing. Conventional mobile terminals and conventional base transceiver stations applying the aircraft profile according to the invention can be used inside the aircraft while aboard to communicate with the conventional external cellular networks.

Some embodiments of the invention are described in independent claims.

#### BRIEF DESCRIPTION OF THE DRAWINGS

Some embodiments of the invention will be described in detail below, by way of example only, with reference to the accompanying drawings, of which

Figure 1a shows an embodiment of the wireless communication system according to the invention,

Figure 1b shows an embodiment of the mobile terminal according to the invention,

Figure 1c shows an embodiment of the first network device according to the invention,

Figure 1d shows an embodiment of the second network device according to the invention,

5 Figure 2 shows an embodiment of the method for providing an aircraft profile mode of wireless communication in a point of view a mobile terminal,

Figure 3 shows an embodiment of the method for providing an aircraft profile mode of wireless communication according to the invention,

10 Figure 4 shows an example of a power level optimization in a method for providing an aircraft profile mode of wireless communication according to the invention,

Figure 5 shows an example of an indoor frequency detection in a method for providing an aircraft profile mode of wireless communication according to the invention, and

15 Figure 6 shows an other example of an indoor frequency detection in a method for providing an aircraft profile mode of wireless communication according to the invention.

## DETAILED DESCRIPTION

The present invention is generally directed to an apparatus and a method for providing a preferable operational mode of wireless communication for a wireless connection between communication devices such as a mobile terminal (MS) and a first network device, where the devices communicate via a wireless connection inside an aircraft, called an indoor connection in this description, or wireless network inside an aircraft, called an indoor network in this description. A preferable operational mode of wireless communication inside the aircraft, called an aircraft profile in this description, shall limit a transmitting power of the devices communicating via the indoor connection or indoor network to a limit power value, wherein the transmitting power is high enough to guarantee an acceptable quality for voice and data transmission inside the aircraft. At the same time the transmitting power shall be low enough not to camp on a network device outside the aircraft, called an external network device in this description. Further, the limit power value of the transmitting power shall overcome the power commands sent by mobile terminals wirelessly

connected to an external network and network devices wirelessly connected to an external network.

Another part of providing the aircraft profile is to find the best frequency value or frequencies values to be used for wireless communication inside the aircraft. The optional selected frequency value or frequencies values do have the least interference with navigation, avionics and other electrical devices used inside the aircraft and do not interfere with external frequencies used in external networks outside the aircraft. On the basis of the selected limit power value and the selected frequency value(s) the aircraft profile is modified to be the operational mode of wireless communication inside the aircraft comprising at least one mobile terminal and at least one first network device inside the aircraft.

By providing a preferable aircraft profile mode of wireless communication for a wireless connection between an indoor mobile terminal and an indoor first network device, where the devices communicate via an indoor connection or indoor network, there are many advantages achieved. Firstly, disturbances between indoor network and other indoor electronic devices and systems are minimized. Secondly, all indoor mobile terminals and indoor network devices are reliably camped on the indoor network without interference with external networks. And thirdly, it is always possible to use in indoor connection or indoor network the frequencies having the least interference without a need to know any information about external network topology and frequencies used in those external networks. The frequencies used inside the aircraft may be selected independently of any specifications and regulations orders of the authorities. The fourth advantage is that it is possible to cover the indoor mobile terminal inside the aircraft while in the air by external, typically terrestrial wireless networks via a satellite link between the indoor network device and the external network device on the ground.

Figure 1a shows an embodiment of the wireless cellular communication system according to the invention in which information is transferred between a mobile terminal 102 and a first network device 104 in an indoor cell or network 100 inside an aircraft. The mobile terminal communicates with the first network device information indicating an operational mode used for a connection between said devices. The mobile terminal 102 is connected via the first network device 104 to the second network device 120 outside the aircraft and the second network device is capable of communicating with external networks 150 using operational modes for wireless communication in accordance with relevant specifications and regulations. The transmission from the first network device 104 of the indoor cell or indoor network

to the second network device 120, and vice versa, is routed via a satellite link 140 using antennas 112 and 122.

According to the invention one or more first network devices 104 may be located inside the aircraft, each of them forming own indoor cell and each of them forming 5 own connection to the second network devices 120. If only one first network device 104 is located inside the aircraft it will establish a indoor cell 100, but if two or more first network devices are located inside the aircraft they will establish a network 100 which is composed of two or more cells.

According to the invention the indoor network 100 and the external network 150 10 are compatible with each other. Preferably, both networks are compliant with at least one of the following communication specifications: GSM (Global System for Mobile communications), PCN (Personal Communication Network), PCS (Personal Communication System), HSCSD (High Speed Circuit Switched Data), GPRS (General Packet Radio Service), EDGE (Enhanced Data rates for GSM Evolution), 15 CDMA (Code Division Multiple Access), WCDMA (Wide band CDMA), Bluetooth, UMTS (Universal Mobile Telecommunications System), Teldesic, Iridium, Inmarsat and WLAN (Wireless Local Area Network). Mobile terminals, network devices and other communication devices in external networks 150, preferably terrestrial cellular networks, communicate with each other using operational modes 20 which are determined in relevant communication specifications and regulations. The indoor mobile terminals 102 and the indoor network devices 104 in the indoor network 100 communicate with each other using the aircraft profile provided according to the invention.

In the preferred embodiment the mobile terminal 102 is a mobile station is a of a 25 cellular network inside the aircraft, the first network device 104 is a base tranceiver station (BTS) of a cellular network inside the aircraft and the second network device 120 is a base station controller (BSC) of a cellular network outside the aircraft.

One example of a wireless network to be used in the wireless communication system according to the invention is the GSM network. The indoor network 100 30 according to the invention may be operated by any telecom operator who, in addition to the indoor network devices 104, fits up the system with external network devices such as mobile switching center (MSC) 130, base station controller (BSC) 120 and network management system 160, and has access to SS7 (Signalling System 7) networks 150. The telecom operator must also have a roaming agreement with a ter-

restrial GSM operator, as well as transmission agreements with satellite communication (satcom) operators or service providers.

Figure 1a shows an embodiment of the wireless cellular communication system according to the invention in which information is transferred between a mobile station (MS) 102 and a base transceiver station (BTS) 104 in an indoor cell 100 inside an aircraft. The MS communicates with the BTS information indicating an operational mode used for a connection between the MS and the BTS. The MS 102 is wirelessly connected via the BTS 104 to base station controller (BSC) 120 being located outside the aircraft and the BSC is capable of communicating with external networks 150 using operational modes for wireless communication in accordance with relevant specifications and regulations. The transmission from the BTS 104 of the indoor cell to the BSC 120, and vice versa, is routed via a satellite link 140 by means of an antenna 112 connected to the BTS and an other antenna 122 connected to the BSC. According to one embodiment of the invention the MS 102 is wirelessly connected via the BTS 104 to base station controller (BSC) 120 outside the aircraft where the BSC is capable of communicating with terrestrial GSM/GPRS networks 150 using operational modes for wireless communication in accordance with terrestrial GSM/GPRS specifications and regulations. The signalling is controlled by a network management system 160 (NMS).

The indoor cell 100 comprises an antenna unit 106 connected to BTS 104 to transmit and receive information wirelessly inside the indoor cell. According to one preferred embodiment of the invention a leaky cable that is routed from front to rear inside the aircraft is used as an antenna 106. The transmitting power level inside the aircraft can be limited to a limit power value which guarantees a uplink range from the indoor BTS to the indoor MS is 5 – 10 meters inside the aircraft. The use of the leaky cable 106 routed from front to rear means that the uplink range is always less than 10 meters independent of the size of the aircraft.

The air frame of the aircraft forms a sealed metal frame, a Faraday cage, which weakens the signal passing through frame and shields from electromagnetic interference coming outside the air frame. This enables to use limited transmitting power levels inside the aircraft because less interference to external radio networks occur inside the aircraft. The transmitting power of the MS and the BTS is controlled by the power control functionality in the radio networks. The power control is based on received field intensity measurements (RxLev) and received signal quality measurements (RxQual) made by the MS and the BTS. Typically, the specifications of the

radio networks define the minimum and maximum transmitting power levels and the transmitting power varies according to the measured RxLev and RxQual values.

In one embodiment of the invention a transmitting power level is limited so that a minimum transmitting power will be approximately the minimum power level of

5 the GSM transmitting power and the maximum transmitting power level will be just a little bit higher than the minimum power level. After an iteration process described more detail in figure 4, there will be a limited transmitting power value, called a limit power value, to enable wireless communication inside the aircraft according to the invention. I.e. the limit power value is high enough to guarantee an

10 acceptable quality for voice, data, audio and video transmission inside the aircraft, and low enough not to camp on external networks outside the aircraft. When the aircraft profile is activated in the MS, the limited power value of the aircraft profile shall always overcome the power commands sent to mobile terminals wirelessly connected to network. This means, that the MS camped on the indoor cell will al-

15 ways use in uplink transmission the limited transmitting power, i.e. the power commands with transmitting power values exceeding the limit power value will be overruled by the power settings of the limit power value in the MS.

In GSM the network always controls the usage power of the MS, when MS has an active call. When making the first connection attempt to network (RACH) in normal  
20 condition the mobile may use full power. According to the present invention the RACH power would also be limited according the aircraft profile.

When a call is active, MS sends measurement reports (downlink quality and level) in each SACCH (about 2 times /s) to BTS. BTS adds own measurements (uplink quality and level) to this message and sends it to BSC. BSC has power control algorithm that calculates the right power for the MS. The power control message is then sent via BTS to MS. PC algorithm may adjust also the BTS power, but typically it is kept static.  
25

It is considered a preferred solution to have the power control algorithm located in the BSC, although the power control algorithm could also in theory locate in BTS system in aircraft. This would require some modification in BSC side, but the benefit would be, that the measurement reports and power commands would not need to be sent via the satellite link. If the power control algorithm is run in aircraft, it is also useful to run the handover algorithm in aircraft. This would mean, that the handover, i.e. having an active call, could be made only inside the aircraft from one  
30

inside cell to another and the external usage is possible only by deactivating the aircraft profile.

The MS acting in aircraft profile shall limit its power level in first attempt and later when connected, although the network would try to command to increase the MS power over the limit. By doing this external network does not hear the MS connection attempts and in other hand the MS power level is always in safe side even if the indoor network would try to increase the power over the limit because of e.g. malfunction or parameter configuration error.

The limit power value is part of the aircraft profile and is included in a power control message transferred between the indoor MS 102 and the indoor BTS 104. It also limits the uplink range to 5 – 10 meters. For example, the MS 102 scans in the idle mode calls from the BTS 104 by monitoring paging channels (PCH) and when the MS identifies its own identity information from the paging channel information the MS will send to the BTS a random access channel (RACH) signal using the limited transmitting power. Then the BTS knows that this MS is allowed to access to the indoor network 100 and the connection is established. Also a location area update (LU) signal is transmitted using the limited power by the MS. In case, the MS identifies PCH calls from any external network cell, the RACH signal it sends to the external cell, will be transmitted using the limited transmitting power. The external cell can't hear the RACH signal, because the uplink range is limited to 5 - 10 meters.

Figure 1a shows a detector unit 118 to find an optional frequency value or frequencies values used inside the aircraft having the least interference with navigation, avionics and other electrical devices to inside use and not having interference with external frequencies used in external networks outside the aircraft. The detector unit 118 is freely located anywhere inside the aircraft and it is connected to the BTS. The detector unit detects frequencies from a group of available frequencies for transmission between the MS and the BTS, and sends a list of frequency values to have the least interference to a CPU 111 of the BTS 104 as shown in figure 1c. To a memory 113 of the CPU 111 is stored threshold values for permissible interference values and specified frequencies of external networks. Based on the list of detected frequencies the CPU 111 calculates at least one frequency value which ensures the least interference with external wireless networks and electrical devices on board the aircraft. The CPU rejects the frequencies that are used in the external networks. Finally, the CPU selects the frequency value to be a transmitting frequency. Then the CPU configures the BTS to use the selected frequency.

When best frequency is calculated in BTS the chosen value has to be sent to BSC and NMS direction. If the handover algorithm is run in BSC, the the handover algorithm must have the information on the used frequency. If the algorithm is run in aircraft, some modification in BSC is needed, so that it may control BTS and MS, without having the handover and power control algorithm.

An alternative version of the frequency selection is, that the inside BTS only sends the measurement data about the measured frequencies and their signal strengths and the real frequency selection algorithm is located in BSC, which then sets/changes the used BTS frequency in normal BTS O&M control manner.

According to another embodiment of the invention the detector unit 118 continuously detects frequencies from a group of available frequencies inside the aircraft. By updating the frequency value it will be guaranteed that the best actual frequency value with the least interference is used for transmission in indoor network 100. Then the CPU 111 configures the BTS to use a new frequency value after every frequency selection made by the CPU of the BTS. In case two or more indoor cells are available, the MSs using the frequency value to be changed to a new frequency value, are first handed over to other indoor cells, and the current cell is shut down. After the frequency value is changed to be the new frequency value the shut indoor cell is opened again. By this way, the configuration of the cell and the change of frequency value is made without dropping ongoing calls.

The limit power value and the frequency value(s) provide the aircraft profile which is included in a signalling information controlled by a network management system 160 (NMS). The BTS inside the aircraft tells to the NMS what limit power value and frequency value the BTS is using. When configuring the aircraft profile mode of wireless communication the BTS relay the signalling information indicating the selected aircraft profile to the BSC, and vice versa. According to one embodiment of the invention the NMS controlling the signalling messages including information of the aircraft profile between the indoor MS 102 and the indoor BTS 104 is located in the CPU 111 of the BTS 104. According to another embodiment of the invention the NMS controlling the signalling messages including information of the aircraft profile between the indoor MS 102 and the indoor BTS 104 is located in a memory 117 of a CPU 115 of the BSC 120 (see figure 1d) which means that the signalling messages including information of the aircraft profile is routed from the MS via the BTS to the BSC, and vice versa, to recognise the MSs with the aircraft profile and allow access for them to the indoor network, and to deny access from the MSs without the aircraft profile.

By this way, wrong MSs without aircraft profile are rejected to connect to network. The BTS denies access from wrong MSs by giving a location update reject message as a reply to a location update attempt from the wrong MS. The Indoor BTS system may have its own SW, that recognizes also the location update message and rejects it, if the attempting mobile does not indicate using the aircraft profile.

The configuration of the aircraft profile mode of wireless communication is established by switching the indoor MS on to the idle mode and selecting the aircraft profile mode among other operational modes. The aircraft profile is stored to a memory 105 in association with a CPU 107 of the MS 102 as shown in a block diagram of the mobile terminal is shown in figure 1b. According one embodiment of the invention the configuration of the MS 102 starts by selecting from the setup display of the user interface (UI) 103 a menu indicating the aircraft mode and pressing a key 101 to activate the aircraft profile mode of the wireless connection between the MS and the BTS 104 inside the aircraft. Another embodiment is to press a special key 101 simultaneously when the MS is turned on to have the aircraft profile selected. The aircraft profile can be switch on and off only after the MS is turned on to the idle mode to prevent the MS to camp on any external cell being present inside the aircraft e.g. in airports. Once the aircraft profile is selected it will overrule all other profile settings. The display unit 109 of the UI of the MS has the clear indication that the aircraft profile has been selected.

The signalling information indicating the selected aircraft profile mode of wireless communication is relayed from the BTS104 to the BSC 120, and vice versa. There is used a satellite link connection to route the wireless connection between the BTS and the BSC and the communication is compliant with external networks, e.g. terrestrial GSM networks. The satellite link is typically off when there is not any traffic, but the mobile communication presumes a non-stop connection. To solve the problem the satellite link connection between the BTS and the BSC comprises switching modules 110, 124 to switch signalling channels and intervals according to allocations so that the link is off when no traffic occurs. As shown in figure 1 c the switching module 110 of the BTS includes an emulator 114 which emulates to the BTS as if the BTS would be wirelessly connected to the BSC while there is not any transmission between the BTS and BSC. In the corresponding way as shown in figure 1 d the switching module 124 of the BSC includes an emulator 123 which emulates to the BSC as if the BSC would be wirelessly connected to the BTS while there is not any transmission between the BTS and BSC. The emulators 114, 123 play the role towards the BTS and the BSC as if they were wirelessly connected all

the time according to the specifications of GSM networks, while in reality the sat-com link is off if there is not any traffic. This is done because the non-stop satellite connection is very expensive.

The emulation functionality is next described in more detail in the context of satellite handovers.

Based on the GSM signalling between BTS and BSC the emulator is used to switch the satellite connection on-off. The emulators will indicate the activation signalling based on the GSM signalling messages when calls are initiated and disconnected, paging requests send to receiving MS. When the MSC-BSC-BTS connectivity can be disconnected the emulator activates the emulator mode towards BTS and BSC according the GSM signalling. Secondly the emulator acts as a connectivity initiator when satellite handovers are taking place. After satellite handover the aircraft emulator will initiate the connection into a ground based emulator and satellite Abis connection will be verified between BTS and BSC node. Emulator will provide routing mechanism for connecting the BTS and BSC in every satellite handover.

In a case where the NSS/BSS system would be regional NSS/BSS system is duplicated in each Satellite region e.g. US, Europe and Asia-Pacific. Due to the fact that GSM BTS is typically stationary and MS mobility and handovers will take place in the network, the aircraft network BTS will move the BSC areas. This will require special implementation in the GSM system. Each regional NSS/BSS will need to be configured in a similar way i.e. duplicate configuration. Due to stationary system there are limitations in the BSC-BTS connectivity in the cross-connection. Based on that fact the BTS should be always connected into the BSC with similar manner. This requirement sets rules for system in the BSC side. Each NSS/BSS region will have own routing addressing. After the satellite handover takes place the aircraft side emulator will initiate the link establishment to regional BSC and emulator. Aircraft emulator needs the information into which regional BSC it will require to be initiating the Abis link. This information can be received from the aircraft avionics system as satellite region information. Based on that information the aircraft emulator will establish a correct routing to the corresponding regional BSC.

The duplicated NSS/BSS in the system means that each BTS needs to be configured according the GSM system setup rules to each BSC. While the BTS is moving and satellite handovers takes place the BTS will change the BSC accordingly. Each BSC needs to have the information of that BTS (BTS id, Cell id, BCF id etc). When the BTS changes the BSC after the emulator connection is established the previous

BSC loses the connection to BTS and NMS inactivates the BTS. In the neighbour region the BTS-BSC connection, transmission link will be established by the emulators.

After the transmission link is up between BTS-BSC the BSC will identify the BTS based on it's identity parameter and will perform parameter download to the BTS accordingly. This act could be identified in the GSM system as Abis connection lost-Abis connection activated in standard manners. However, what is different is when the Abis is "lost" i.e. the satellite region is changed the BTS changes the BSC i.e. Location area. Therefore the BTS coming into new BSC-location area the BSC will update the BTS parameter set accordingly. It is required that all the BTS's are configured into NMS accordingly so that each BTS will be found in each BSC. When BTS changes the BSC the BTS will be inactivated in the previous BSC-NMS and activated in the neighbour BSC-NMS.

Figure 2 shows an embodiment of the method for providing an aircraft profile mode of wireless communication in a point of view a mobile terminal, preferably the mobile station (MS). In step 202 the MS is turned on inside the aircraft and the MS is switched on to the idle mode. Then in step 204 the setup display of the MS shows a menu, where the user selects the operational mode to be the aircraft profile mode. The selection in step 206 can be done from the menu by pressing a key. The alternative way to select the aircraft profile is to press a special key simultaneously when the MS is switched on in step 202. To ensure that the selection of the operational mode was correct it will be checked in step 208. If the selection was wrong, e.g. a normal GSM mode was selected, the operation of the MS is blocked according to step 232 and the MS is turned off in step 234. The purpose of step 208 is to secure that only the aircraft profile mode of operation is allowed. Now the MS is wirelessly connected to the indoor cell and it is in idle mode of operation. The MS roams only to the neighbouring frequencies available inside the aircraft. Next in step 210 the MS starts scanning available frequencies inside the aircraft and it roams to the BTS of the indoor cell. In step 212 the MS is configured to the aircraft profile according to the message indicating aircraft profile information from the BTS. If another MS is roaming to the indoor MS with the aircraft profile settings, it will be checked in step 214 whether the settings of that other MS are according to the aircraft profile. If not, the access is denied from that other MS in step 236.

Next in step 216 the MS camps on the indoor BTS and the wireless connection is established. In case there is a need to change the frequency in step 218 to a new fre-

quency value having less interference than the previous frequency value, the frequency is changed in step 244.

In a GSM system this is arranged in such a way that when the mobile station is in idle mode camped on one cell, it changes the cell by itself. The BTS further gives

- 5 the information about the neighbour cells and also gives change rules and parameters for the mobile cell selection algorithm. In the arrangement according to the present invention, when the frequency of one of the inside BTSs is changed the idle mode mobiles camped on this cell, will automatically camp on the neighbour cell. Those MSs that have an active call then have to be handed over to a neighbour cell,
- 10 otherwise the call is dropped. The changed frequency also has to be informed to other neighbour BTS, i.e. the entity, that sets the BTS frequency, so that the old frequency can be removed from neighbour list and new can be added. In the same way the new frequency information has to be informed to the handover algorithm, so that it can make the handover.

- 15 In addition there may be added counters that collect the information about the frequency changes of the inside BTS. Similar counters may be added to collect information about inside made location update rejects and handovers. Typically this counter information is collected in the NMS system.

Then in step 242 the MS using the frequency value to be changed to a new frequency value, is first handovered to the other indoor cell, and the current cell is shut down. The handover may here mean either a base station forced handover or camping of a mobile staion according to the neighbour cell information. After the frequency value is changed to be the new frequency value in step 244 the shut indoor cell is opened again. Then according to step 216 the MS camps on the opened indoor cell again. By this way, the configuration of the cell and the change of frequency value is made without dropping ongoing calls.

- 20 Figure 3 shows an embodiment of the method for providing an aircraft profile mode of wireless communication according to the invention. In step 300 the indoor cell is activated by turning on the BTS inside the aircraft. Next the MS is turned on to the idle mode and the aircraft profile mode is selected according to step 301 as described in figure 2 steps 202 – 210. To generate the aircraft profile in step 303 the transmitting power of the MS and the BTS inside the aircraft is limited to a limit power value which ensures a quality of service of the connection and does not interfere with external wireless networks. In step 305 the best frequency value or frequency values ensuring the least interference with external wireless networks are se-
- 25
- 30
- 35

lected to the indoor cell(s) use. Step 303 is presented more detail in figure 4 and step 305 in association to figures 5 and 6.

The aircraft profile is then generated in step 307 on the basis of said limit power value and said frequency value(s) and the MSs and the BTSs inside the aircraft configured to the aircraft profile in step 309. The information indicating that the aircraft profile mode is used is attached to the signalling information transferred between the MS and the BTS in step 311. Then in step 313 the wireless connection using the aircraft profile is established inside the aircraft and in step 315 the BTS establishes a wireless connection to the BSC which is connected to the network management system (NMS) of external networks. Now the wireless link from the indoor MS via indoor BTS to the external BSC is established. The information indicating that the aircraft profile mode is used is also relayed to BSC and NMS of external networks attached to the signalling information in step 315.

To ensure that any wrong MS or external communication device can't interfere or get access to the indoor cell, it will be checked in step 317 if any RACH bursts or location update requests are sent from devices with wrong profile settings. If false attempts are monitored, the indoor BTS sends the location update reject message. In step 319 the indoor MS communicates wirelessly via the indoor BTS cell with another indoor MS or with an external MS of the external network via the wireless link between the indoor BTS and the BSC to be connected to the external network.

It is noted that in a GSM system it is also possible to adjust transmission power level of the mobile station with SYSTEM INFO messages that are transmitted on the broadcast channel BCCH. This message includes a parameter MS-TX-ALLOWED that informs the mobile station the maximum allowed transmission power for the transmission for a mobile stat. In standard systems this parameter is generally kept at the maximum value in order to secure that the RACH burst can be received, but a smaller parameter could be used as well. This procedure is, however, different from using an aircraft profile that is given controlled by the BTS because using the aircraft profile is independent on the settings of the BTS in the network. So even if the transmission power in the cell inside the aircraft would be adjusted to maximum by mistake, the mobile station would still transmit on a smaller power thus decreasing the probability that the RACH would be received by external BTSs.

Figure 4 shows an example of a power level optimization in a method for providing an aircraft profile mode of wireless communication according to the invention. Figure 4 presents the step 303 of figure 3 more detail. In step 401 the transmitting

power limitation process is started to generate the aircraft profile for indoor network communication. First a minimum transmitting power value is selected depending on specifications of the external network to be compliant with the indoor network. In one embodiment of the invention a transmitting power level is first limited so that a minimum transmitting power will be approximately the minimum power level of the GSM transmitting power in step 403. If the first selected transmitting power value does not ensure acceptable voice, audio, video and data transmitting quality between the MS and the BTS inside the aircraft in step 404, the transmitting power level is increased a little bit according to step 406. Then the quality of service is tested again in step 405 and loop is repeated so many times as the result is sufficient. Still when the maximum power value of aircraft profile is reached, 405, this power is not anymore increased although the QoS means the power should be raised. The antenna design inside the aircraft shall be done in such a way that this situation does not occur.

- 15 If the first selected transmitting power value ensures acceptable voice, audio, video and data transmitting quality inside the aircraft in to step 404, then it is checked whether the wireless connection between the indoor MS and the indoor BTS ensures that external communication devices of external wireless networks are unable to receive a connection request sent by the indoor MS inside the aircraft
- 20 First it is checked whether the QoS is much higher than necessary, ie. higher than a predetermined upper limit value. If the QoS value exceeds the upper limit value the transmitting power is decreased in step 409. This loop of steps 407, 409 is repeated as long as the QoS value is no more higher than the upper limit value. Next it is checked in step 408 whether there is interference within the cell. If an predetermined interference limit is exceeded, it is further checked in step 410 whether the QoS clearly exceeds a predetermined minimum value. If it does, the transmission power is decreased in step 409. This loop is repeated as long as the interference is below the limit value or a minimum QoS value has been reached.

- 30 There is no way to actually detect by the indoor BTS, whether some indoor MS is still able to connect external BTS, i.e. is the external BTS able to hear the MS, because there is no link between the indoor BTS and an external BTS of some external GSM system. However, since the MS power is limited by the profile to such a low value, the external network does not detect the inside low power MS connection attempt (RACH). And further, when the MS has aircraft profile active, it may disable the connection attempts to such networks, that do not indicate e.g. in system info messages, that they are using aircraft profile.

When the optimal transmitting power level is found, this optimal transmitting power is selected to be the limit power value for the aircraft profile in step 411 and the transmitting power inside the aircraft is limited to this limit power value in step 413. According to one embodiment the connection request sent by the MS is a RACH burst. According to another embodiment the connection request sent by the MS is a location update request. The limit power value for the aircraft profile is selected in step 411.

Figure 5 shows an example of an indoor frequency detection in a method for providing an aircraft profile mode of wireless communication according to the invention. Figure 5 presents an embodiment of the step 305 of figure 3 more detail. Here it is assumed that the indoor BTS is switched on in step 501 just before before detection process. When the indoor BTS is switched on in step 501 the detector unit inside the aircraft starts detecting frequencies from a group of available frequencies inside the aircraft for transmission between the MS and the BTS according to step 503. Then based on the detecting the CPU of the BTS calculate the most useable frequency value or frequency values from a list of frequencies the detector has detected in step 505. The most useable frequency value(s) ensures the least interference with external wireless networks.

Then in step 507 it is checked whether the calculated frequency value(s) are the same frequencies used in external wireless networks. If the calculated frequency value(s) are not the same as used in external networks, the frequency value or these frequency values are selected to be the frequency value or frequency values for the aircraft profile in step 509. If the calculated frequency value(s) are found in step 507 to be the same as used in external networks, the detector unit inside the aircraft starts again detecting frequencies from a group of available frequencies inside the aircraft for transmission between the MS and the BTS according to step 503. In one embodiment, if the calculated frequency value(s) are found in step 507 the same as used in a GSM, PCS or other frequency bands compliant with communication specifications, the detector unit inside the aircraft starts again detecting frequencies from a group of available frequencies inside the aircraft for transmission between the MS and the BTS according to step 503. The frequency value for the aircraft profile is selected in step 509.

Figure 6 shows an other example of an indoor frequency detection in a method for providing an aircraft profile mode of wireless communication according to the invention. Figure 6 presents another embodiment of the step 305 of figure 3 more detail. Here it is assumed that the indoor BTS has been switch on in step 601 before

the detection process, and the detection process is run continuously. In step 603 the detector unit inside the aircraft detects frequencies from a group of available frequencies inside the aircraft for transmission between the MS and the BTS.

Then based on the detecting the CPU of the BTS calculate the most useable frequency value or frequency values from a list of frequencies the detector has detected in step 605. The most useable frequency value(s) ensures the least interference with external wireless networks. After the calculation process there is a list of the most useable calculated frequency values in step 607. Then using the loop of steps 609, 611 and 607, it is checked which one of the calculated frequency values from the list has the least interference inside the aircraft and the least interference with external networks.

The most optimum frequency value is selected in step 613 to be a frequency value for the aircraft profile. Because the detection process is continuous, in step 615 it is checked whether the new frequency value is the same as the current frequency value. In step 615 it is also checked if only one indoor cell is in use. If the current frequency value and new frequency value is the same frequency value the connection maintains unchanged according to step 616 and the detection process also continues if wanted in step 617. If the current frequency value in step 613 is different than the new frequency value, it means that the detector has found a new frequency value with less interference than the current one.

In one embodiment where only one indoor cell is available the frequency value of the connection is changed in step 616. In another embodiment where two or more indoor cells are available a handover of the connection is performed first to the MS and the BTS using the most interference frequency value among selected frequency values according to step 617. The MS connected to the BTS using the most interference frequency is handovered to other indoor cell and the BTS is shut down in step 619. Then the shut BTS is configured with a new frequency value in step 621 and the shut BTS is opened again in step 623. By this way, the configuration of the cell and the change of frequency value is made without dropping ongoing calls. The selection to continue or stop the detection process is done in step 627. If the detection is stopped the connection continues with the current frequency value. The frequency value for the aircraft profile is selected in step 613.

The invention is not restricted to the embodiments described above. While a preferred embodiment of the present invention is disclosed herein for purposes of explanation, numerous changes, modifications, variations, substitutions and equiva-

lents in whole or in part should now be apparent to those skilled in art to which the invention pertains. Accordingly, it is intended that the present invention be limited only the characteristics and scope of the hereto appended claims.

The idea of using emulators can also be used independently, so it is not in any way  
5 restricted to using an aircraft profile but can also be considered as an independent invention.

The invention has been described in the context of aircraft application. However,  
the invention is not in any way limited to aircraft use but the idea can also be used  
in other vehicles such as bullet trains or ships. The aircraft profile can thus be a  
10 "vehicle profile" for any moving vehicle. The scope of protection thus also covers  
such applications.

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## Claims

1. A method for providing an operational mode of wireless communication between at least one mobile terminal (102) and at least one first network device (104) inside a vehicle, such as aircraft, the method comprising steps of:

- 5 - communicating from the mobile terminal information indicating an operational mode that the mobile terminal uses for a wireless connection between the mobile terminal and the first network device inside the aircraft,
- connecting the mobile terminal via the first network device (104) inside the aircraft to wirelessly communicate with a second network device (120) outside the aircraft, where the wireless connection between the first network device and the second network device uses an operational mode of communication capable of communicating with external wireless networks (150) outside the aircraft,

### **characterised by**

- limiting a transmitting power value for a wireless connection (303) between the mobile terminal and the first network device to a limit power value,

- selecting said limit power value on the basis of providing a determined quality of service of the connection and minimizing interference with external wireless networks (411),

- selecting at least one frequency value (305, 509, 613) to establish a wireless connection between the mobile terminal and the first network device on the basis of minimizing the interference effect with external wireless networks, and

- configuring the operational mode of communication (212) in the wireless connection inside the aircraft on the basis of said limit power value and said frequency value.

25 2. A method according to claim 1, **characterized** in that such limit power value for the wireless connection between the mobile terminal and the first network device is selected which ensures acceptable voice and data transmitting quality (404) inside the aircraft.

30 3. A method according to claim 1 or 2, **characterized** in that such limit power value for the wireless connection between the mobile terminal and the first network device is selected which ensures that network devices of external wireless networks

are unable to receive a connection request sent by the mobile terminal (317, 407) inside the aircraft.

4. A method according to claim 3, **characterized** in that such limit power value for the wireless connection between the mobile terminal and the first network device is selected which ensures that network devices of external wireless networks are unable to receive a location update request sent by the mobile terminal (317, 407) inside the aircraft.
5. A method according to claim 1 or 2, **characterized** in that the selected limit power value for the wireless connection between the mobile terminal and the first network device overrules a transmitting power command (321) given by any external wireless network.
- 10 6. A method according to claim 1, **characterized** in that the step of selecting at least one frequency value comprises further steps of:
  - detecting frequencies from a group of available frequencies (503, 603) inside the aircraft for transmission between the mobile terminal and the first network device, and based on the detecting
  - determining at least one frequency value (505, 605) which provides least interference with external wireless networks.
- 15 7. A method according to claim 6, **characterized** in that the group of available frequencies excludes frequencies used in external wireless networks (507).
8. A method according to claim 6 or 7, **characterized** in that the group of available frequencies excludes frequencies used in a GSM, PCS or other frequency bands compliant with communication specifications (507).
- 20 9. A method according to claim 6, **characterized** in that the step of detecting frequencies from a group of available frequencies is run when establishing the wireless connection between the mobile terminal and the first network device (503).
10. A method according to claim 6, **characterized** in that the step of detecting frequencies from a group of available frequencies is run continuously, and on the basis of detecting several frequency values are used for transmission between the mobile terminals and the first network devices (603, 627).

11. A method according to claim 10, **characterized** in that a handover is performed to a number of mobile terminals, wherein the handover is performed first to the mobile terminals (242, 617) and the network devices using the frequency value causing most interference among selected frequency values.
- 5 12. A method according to any of claims 6 to 11, **characterized** in that the step of detecting comprises a further step of realying information indicating the selected frequency value of communication from the first network device to the second network device (311, 315).
- 10 13. A method according to any of claims 6 to 11, **characterized** in that the step of detecting comprises a further step of realying information indicating the need of change the selected frequency value of communication from the first network device to the second network device (311, 218).
14. A method according to claim 1, **characterized** in that the step of configuring the operational mode of communication comprises further steps of:
- 15 - establishing a wireless connection between the mobile terminal and the first network device (216) inside the aircraft, and  
- relaying information indicating the selected operational mode of communication from the first network device to a second network device and vice versa (311, 313, 315).
- 20 15. A method according to claim 14, **characterized** in that the step of establishing the wireless connection comprises a step of selecting an operational mode of communication in a wireless network inside the aircraft when the mobile terminal is switched on inside the aircraft (206), and after the selection of the operational mode the wireless connection is established (216).
- 25 16. A method according to claim 14 or 15, **characterized** in that the step of establishing the wireless connection comprises a step of displaying on the mobile terminal an operational mode of communication in a wireless network (204) inside the aircraft when the mobile terminal is switched on (202) inside the aircraft.
- 30 17. A method according to claim 14, **characterized** in that the step of establishing the wireless connection comprises a step of transmitting a RACH burst using the limit power value (313) from the mobile terminal to the first network device when the mobile terminal is switched on.

18. A method according to claim 14, **characterized** in that the step of establishing the wireless connection comprises a step of disabling a wireless connection between the mobile terminal and the first network device using the operational mode of the external network (232, 236).

5 19. A method according to claim 18, **characterized** in that the step of establishing the wireless connection comprises a step of sending a location update rejection from the mobile terminal and the first network device as a reply to a location update request from the external wireless network (232, 236).

10 20. A method according to claim 14, **characterized** in that the step of realying information indicating the selected operational mode comprises signalling information from the first network device and the second network device and vice versa (311, 315).

15 21. A method according to claim 14, **characterized** in that the step of realying information indicating the selected operational mode comprises a RACH burst using the limit power value from the first network device and the second network device and vice versa (311, 315).

20 22. A method according to claim 1, **characterized** in that the method is compliant with at least one of the following communication specifications: GSM, PCN, PCS, HSCSD, GPRS, EDGE, CDMA, WCDMA, Bluetooth, UMTS, Teldesic, Iridium, Inmarsat and WLAN.

23. A method according to claim 1, **characterized** in that the wireless connection between the mobile terminal and the first network device is established by a wireless network inside the aircraft (313).

25 24. A system for wirelessly communicating information between a mobile terminal inside a vehicle, such as an aircraft, and a first network device inside the aircraft, the system comprising:

30 - at least one mobile terminal (102) for wirelessly communicating with the first network device (104) information indicating an operational mode that is used for a wireless connection between the mobile terminal and the first network device inside the aircraft,

- at least one first network device for wirelessly connecting the mobile terminal to communicate with a second network device (120) outside the aircraft where the

connection between the first network device and the second network device uses an operational mode of wireless communication capable of communicating with external wireless networks (150) outside the aircraft,

- at least one second network device outside the aircraft for wirelessly communicating with external wireless networks,

5 **characterised in that**

- the mobile terminal is arranged to limit a transmitting power value for a wireless connection with the first network device to a first limit power value, wherein said first limit power value is based on quality of service of the connection and amount 10 of interference with external wireless networks,

- the first network device is arranged to limit a transmitting power value for a wireless connection with the mobile terminal to a second limit power value wherein said second limit power value is based on achieving a determined quality of service of the connection and minimizing the amount of interference with external wireless 15 networks,

- the system is arranged to select at least one frequency value to establish a wireless connection with the mobile terminal which frequency value is based on providing least interference with external wireless networks, and

- the system is arranged to configure the operational mode of wireless communication in the wireless connection inside the aircraft on the basis of said limit power values and said frequency value.

25. A system according to claim 24, **characterized** in that at least one frequency value is selected, the system inside the aircraft comprises:

- means for detecting frequencies (118) from a group of available frequencies for transmission between the mobile terminal and the first network device, and based 25 on the detecting

- means for calculating at least one frequency value (111, 113) which provides least interference with external wireless networks.

30 26. A system according to claim 24, **characterized** in that the first network device comprises an antenna (106) for wireless information transmission inside the aircraft.

27. A system according to claim 26, **characterized** in that the first network device comprises a leaky cable (106) for wireless information transmission inside the aircraft, where the leaky cable is routed from front to rear inside the aircraft.
28. A system according to claim 24, **characterized** in that the configuring the operational mode of wireless communication is arranged to:
- establish a wireless connection between the mobile terminal and the first network device inside the aircraft, and
- relay information indicating the selected operational mode of wireless communication from the first network device to the second network device, and vice versa.
29. A system according to claim 28, **characterized** in that the means for relaying information comprises a first switching module (110) associated to the first network device to be connected via a wireless connection link (112, 140, 122) to a second switching module (124) which locates associated to the second network device for transmitting information indicating the selected operational mode.
30. A system according to claim 29, **characterized** in that the wireless connection between the first switching module and the second switching module is routed via a satellite link (140).
31. A system according to claim 30, **characterized** in that the first switching module (110) comprises a first emulator (114) and the second switching module (124) comprises a second emulator (123), where the first emulator emulates to the first network device that the first network device is wirelessly connected to the second network device while there is not any transmission between the first and second network devices, and the second emulator emulates to the second network device that the second network device is wirelessly connected to the first network device while there is not any transmission between the first and second network devices.
32. A system according to claim 24, **characterized** in that the first network device (104) is a base transceiver station (BTS) and the second network device (120) is a base station controller (BSC).
33. A system according to claim 24, **characterized** in that the wireless connection between the mobile terminal and the first network device is established by a wireless network (100) inside the aircraft.

34. A system according to claim 24, **characterized** in that the system is compliant with at least one of the following communication specifications: GSM, PCN, PCS, HSCSD, GPRS, EDGE, CDMA, WCDMA, Bluetooth, UMTS, Teldesic, Iridium, Inmarsat and WLAN.

5 35. A first network device for communicating information via a wireless connection to a mobile terminal (102) inside a vehicle, such as an aircraft, and for communicating information via wireless connection link (112, 140, 122) to a second network device (120) capable of communicating in external wireless networks (150) outside the aircraft, the first network device comprising:

10 - means for transmitting information to the mobile terminal (106) in a wireless network (100), the information indicating an operational mode that the mobile terminal uses for a wireless connection between the mobile terminal and the first network device,

15 - means for connecting the mobile terminal inside the aircraft to wirelessly communicate (112, 110, 111) with a second network device outside the aircraft, where the wireless connection between the first network device and the second network device uses an operational mode of wireless communication capable of communicating with external wireless networks,

**characterised** in that the first network device is arranged to:

20 - limit a transmitting power value for a wireless connection with the mobile terminal to a limit power value which provides at least a determined a quality of service of the connection and a minimum of interference with external wireless networks,

- select at least one frequency value to establish a wireless connection with the mobile terminal which frequency provides minimum interference with external wireless networks, and

- configure the operational mode of wireless communication in the wireless connection inside the aircraft on the basis of said limit power value and said frequency value.

36. A first network device according to claim 35, **characterised** in that the first network device comprises an antenna (106) for wireless information transmission inside the aircraft.

37. A first network device according to claim 36, **characterised** in that the first network device comprises a leaky cable (106) for wireless information transmission inside the aircraft, where the leaky cable is routed from front to rear inside the aircraft.

5 38. A first network device according to claim 35, **characterized** in that the configuring the operational mode of wireless communication is arranged to:

- establish a wireless connection between the mobile terminal and the first network device inside the aircraft, and

- have means for relaying information indicating the selected operational mode of wireless communication from the first network device to the second network device, and vice versa.

10 39. A first network device according to claim 38, **characterized** in that the means for relaying information comprises a first switching module (110) to be connected via a wireless connection link (112, 120, 122) to a second switching module (124) which locates associated to the second network device for transmitting information indicating the selected operational mode.

15 40. A first network device according to claim 39, **characterized** in that the first switching module comprises a first emulator (114) to emulate to the first network device that the first network device is wirelessly connected to the second network device while there is not any transmission between the first and second network devices.

20 41. A first network device according to claim 35, **characterized** in that the wireless connection between the mobile terminal and the first network device is established by a wireless network (100) inside the aircraft.

25 42. A mobile terminal for communicating information wirelessly to at least one first network device inside an aircraft, the mobile terminal comprising:

- a transmitter for transmitting information to the first network device in a wireless network (100), the information indicating an operational mode that the mobile terminal (102) uses for a wireless connection between the mobile terminal and the first network device,

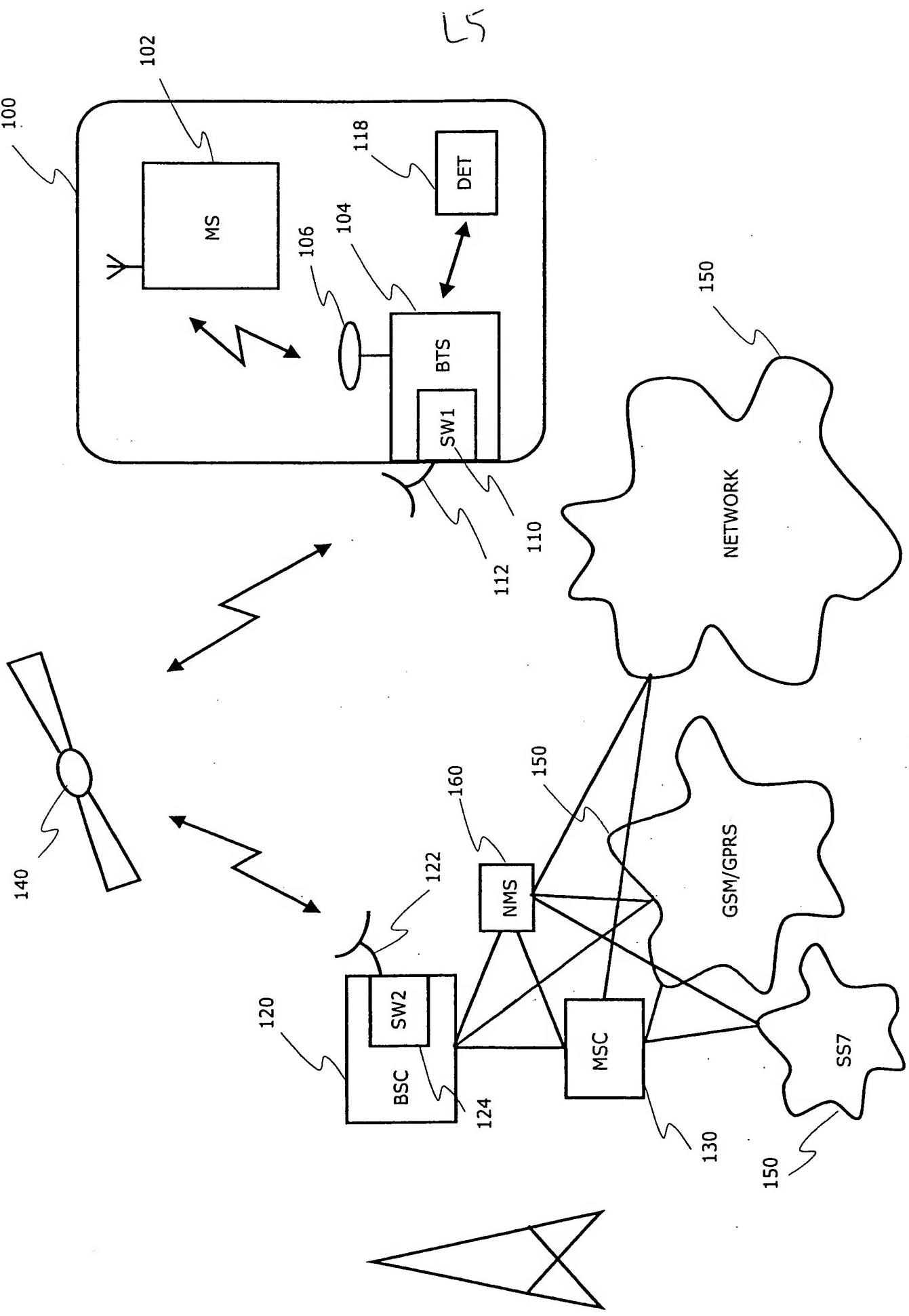
30 **characterised** in that the mobile terminal further comprises

- means for transmitting the information to the first network device using an operational mode of wireless communication to limit a transmitting power value to a limit power value which provides at least a determined quality of service of the connection and a minimum interference with external wireless networks outside the aircraft,
    - means for receiving a command from the first network device indicating an operational mode of wireless communication and indicating a frequency value to establish a wireless connection to the first network device which frequency value provides minimum interference with external wireless networks, and
  - 10 - means for selecting (103, 109, 101) an operational mode of wireless communication configured in the wireless connection inside the aircraft on the basis of said limit power value and said frequency value.
43. A mobile terminal according to claim 42, **characterized** in that it comprises means for displaying (109) said selected operational mode.
- 15 44. A mobile terminal according to claim 42, **characterized** in that a menu (107, 105, 109) and a key (101) is used to select and a display unit is used to indicate the operational mode of wireless communication for the wireless connection inside the aircraft.
- 20 45. A mobile terminal according to claim 42, **characterized** in that the wireless connection between the mobile terminal and the first network device is established by a wireless network (100) inside the aircraft.

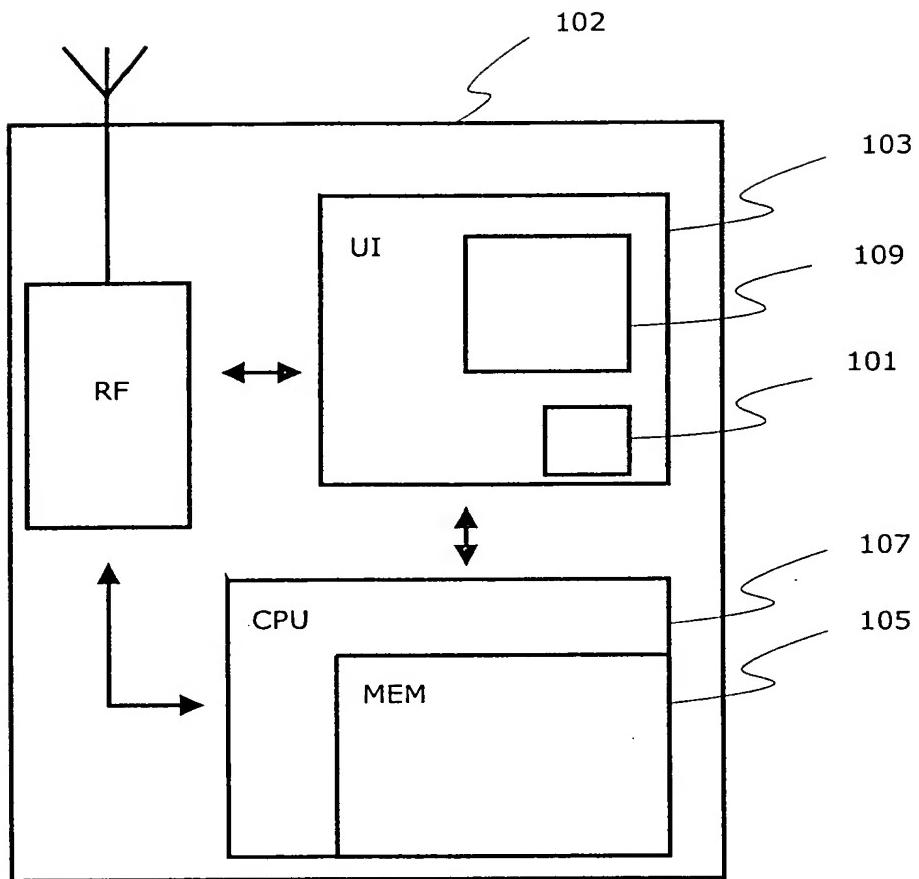
**(57) Abstract**

The present invention provides an operational mode of communication which adjusts a transmitting power of a cellular system and a mobile terminal used inside a vehicle, such as an aircraft, so that the mobile terminals (102) inside the aircraft camp on the indoor cellular network (100) inside the aircraft and do not interfere with external cellular networks. This reduces possible electromagnetic interference with avionics inside the aircraft, because the transmitted power levels is limited. The frequency band used by the indoor cellular network can be determined by the service provider independent of frequency bands allocated by communication specifications and regulations. Conventional mobile terminals (102) and conventional base transceiver stations (104) applying the aircraft profile according to the invention can be used inside the aircraft while aboard to communicate with the conventional external cellular networks (150).

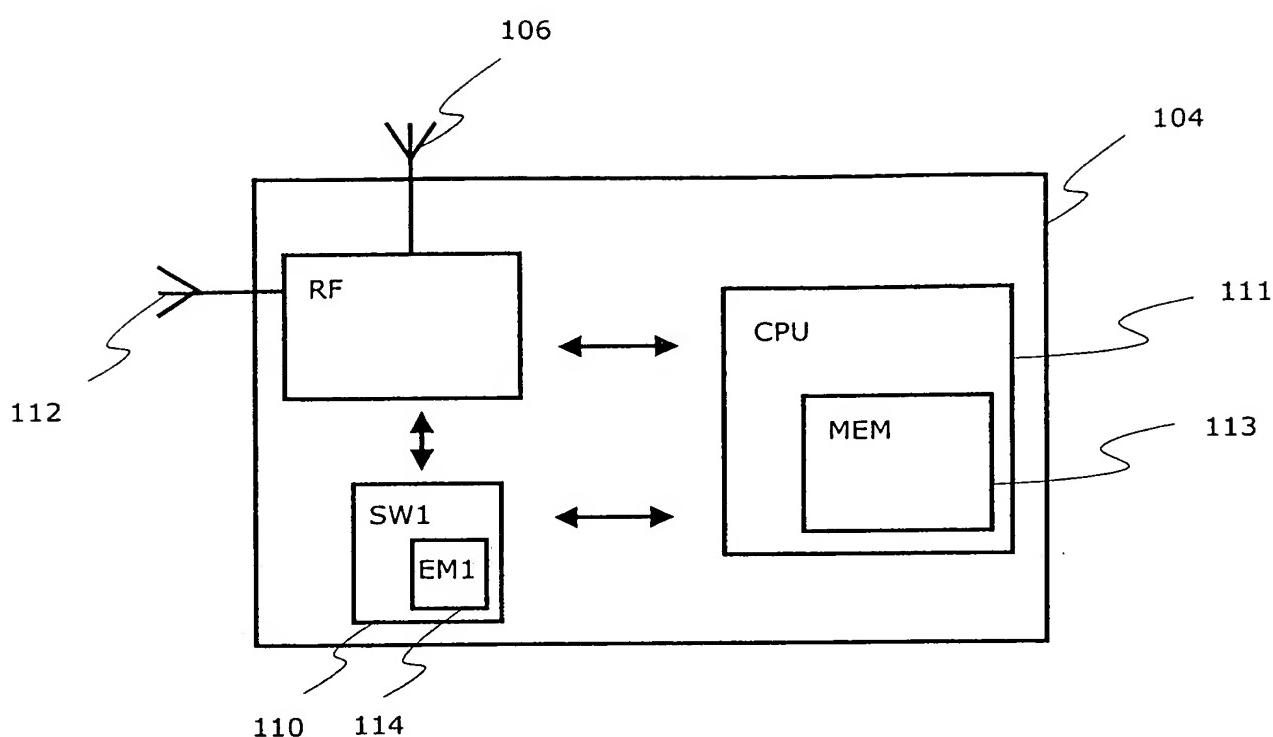
(Figure 1a)



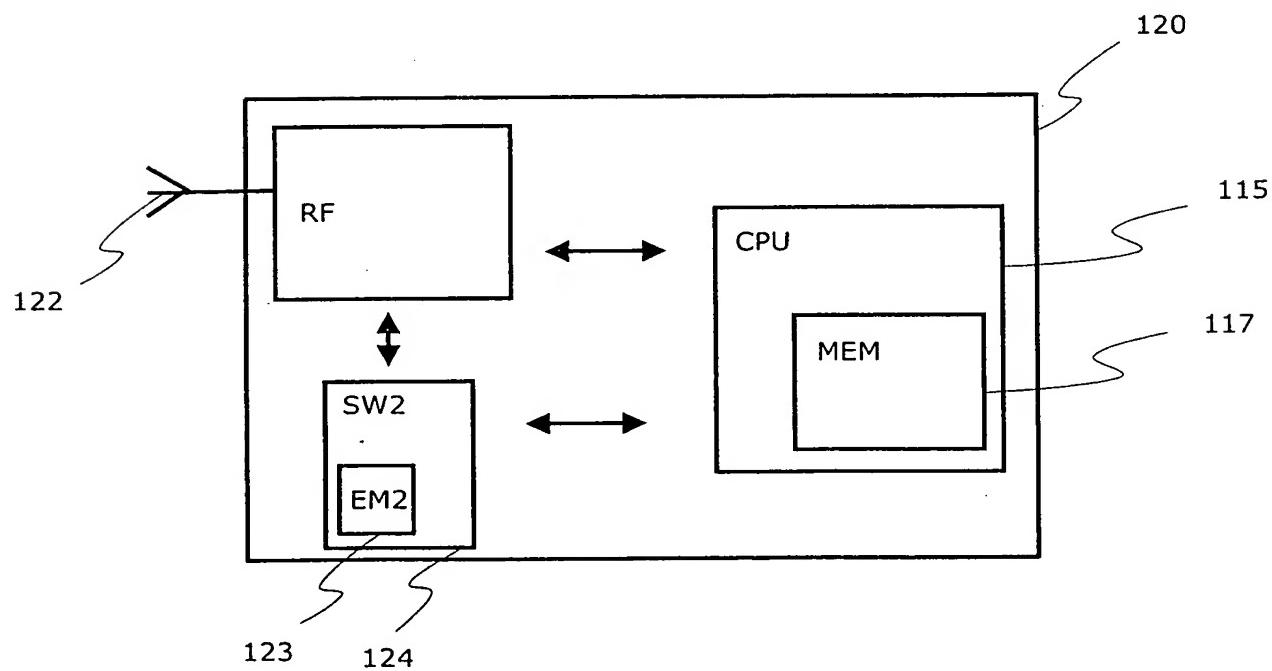
**Fig 1a.**



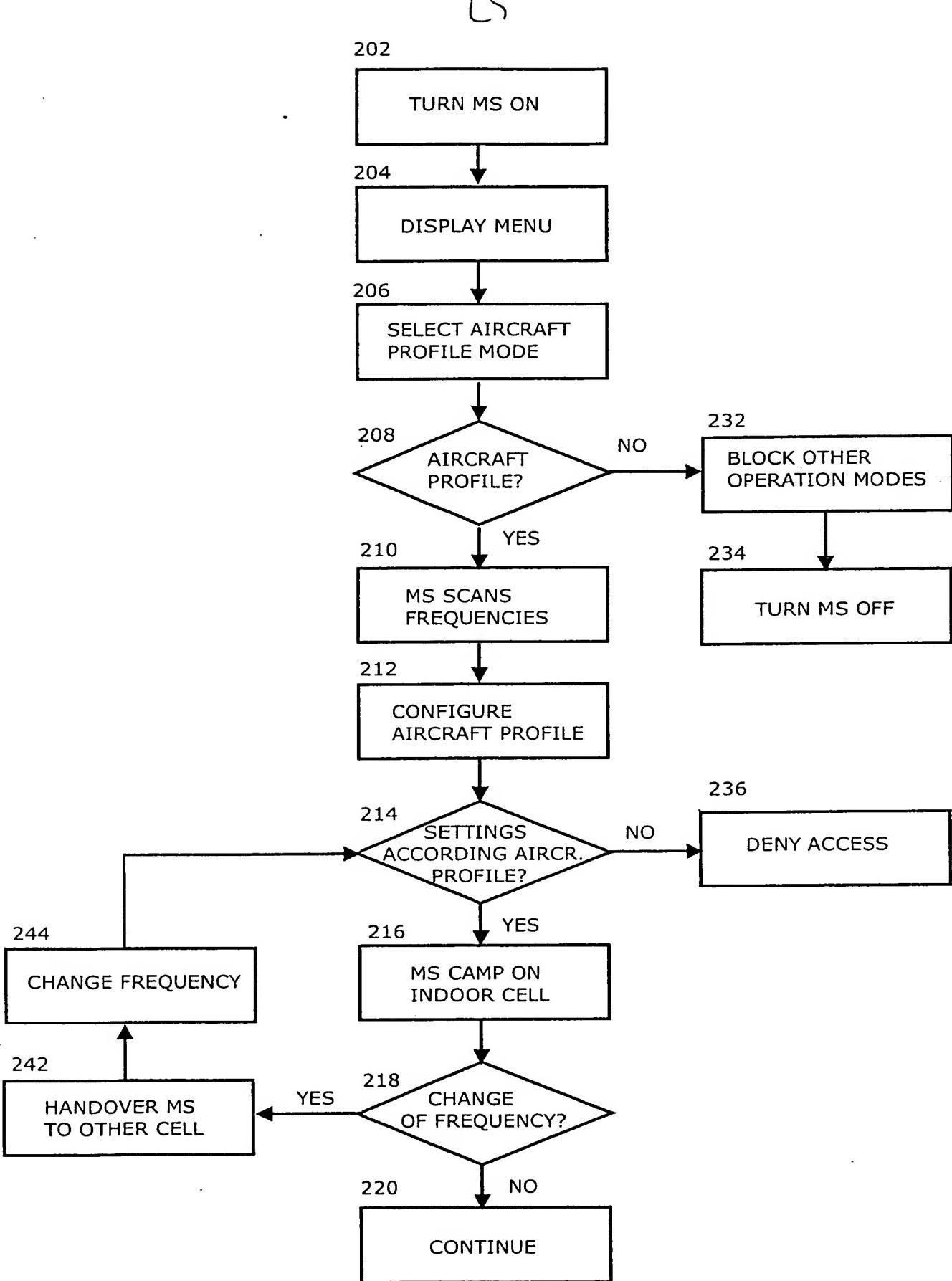
**Fig 1b.**



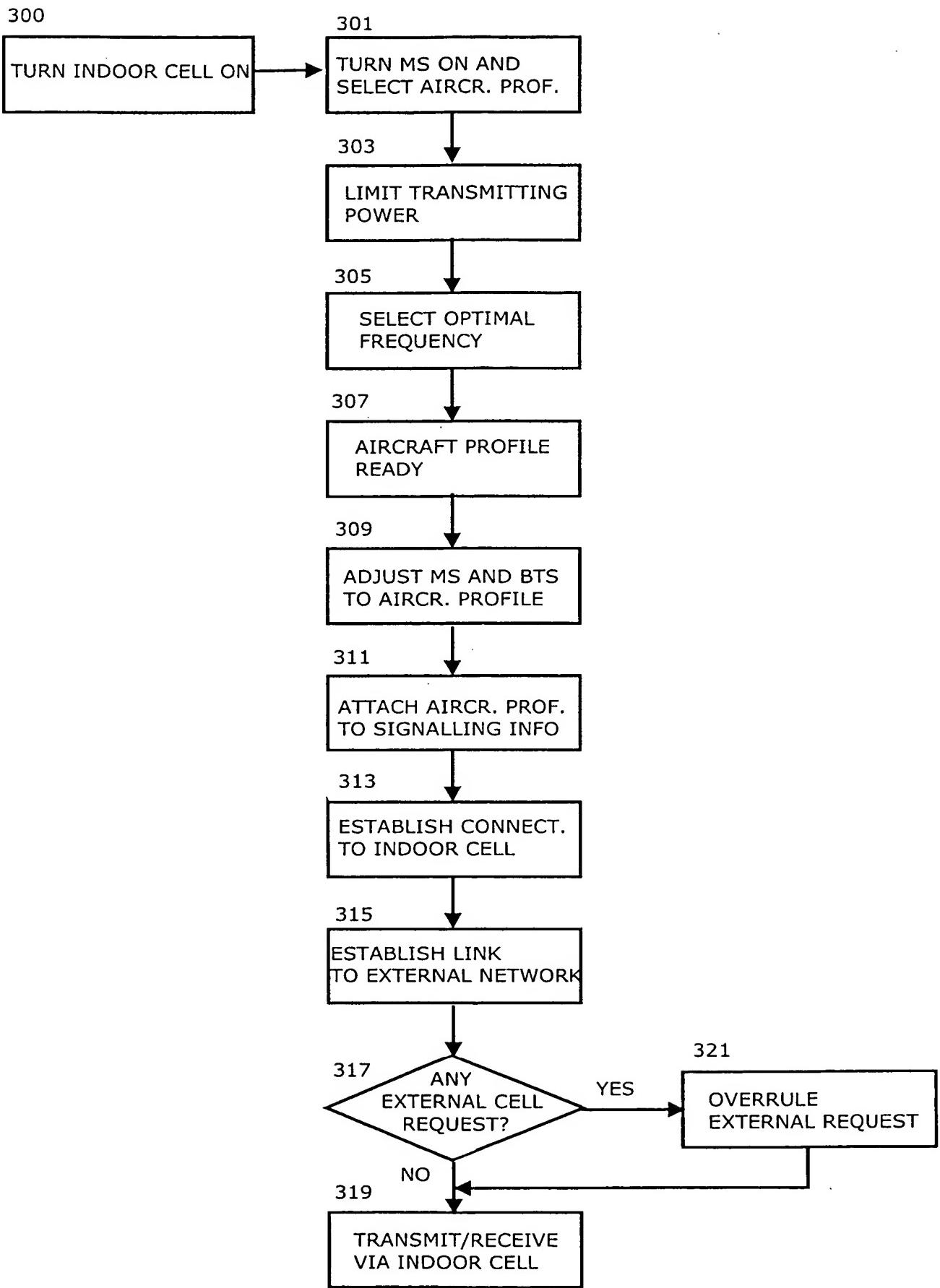
**Fig 1c.**



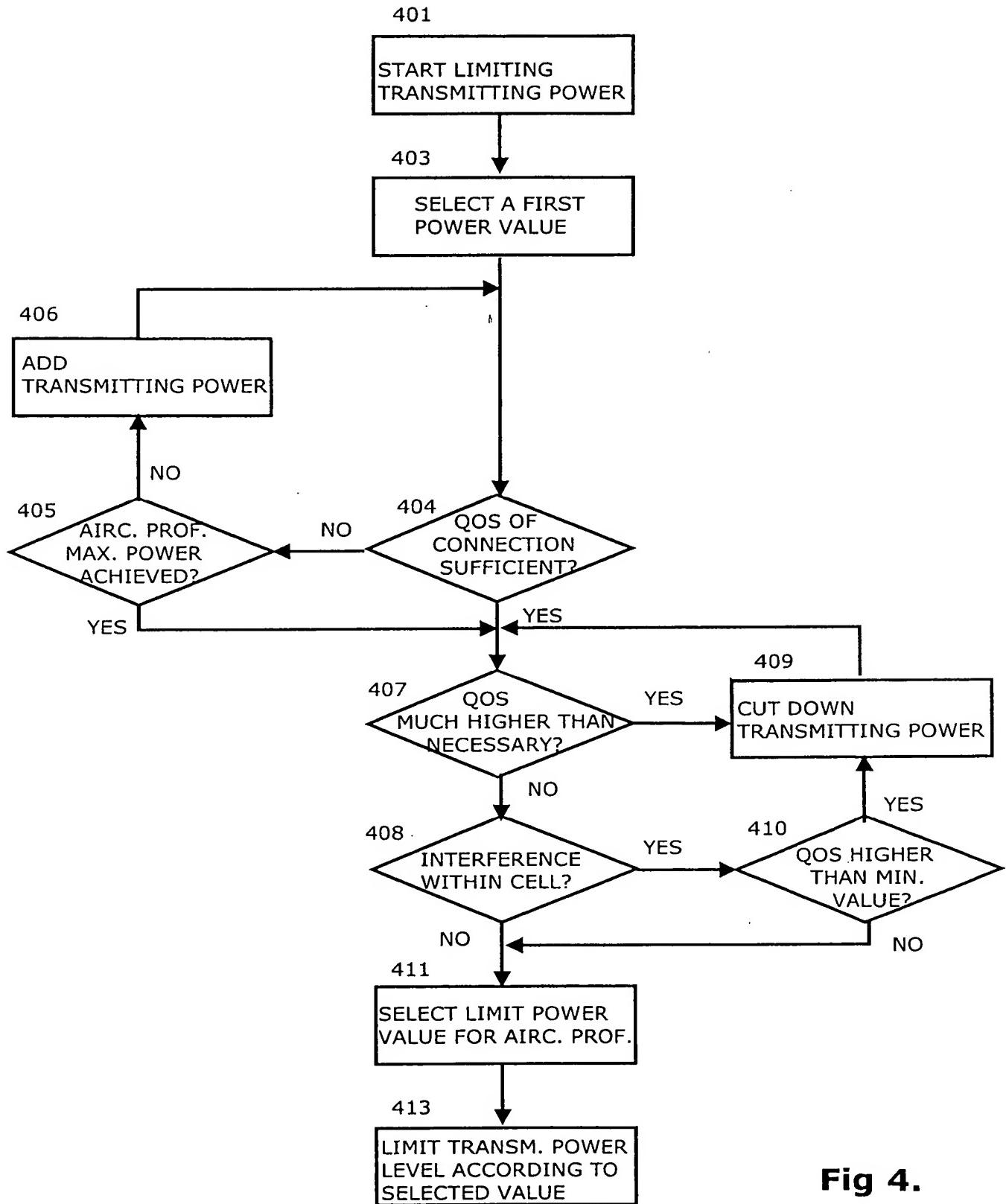
**Fig 1d.**



**Fig 2.**



**Fig 3.**

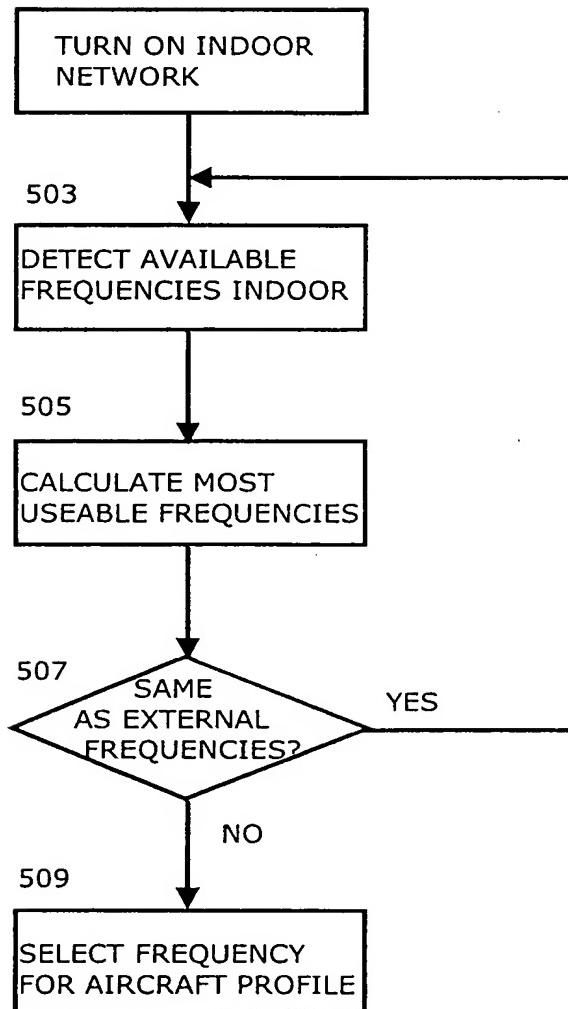


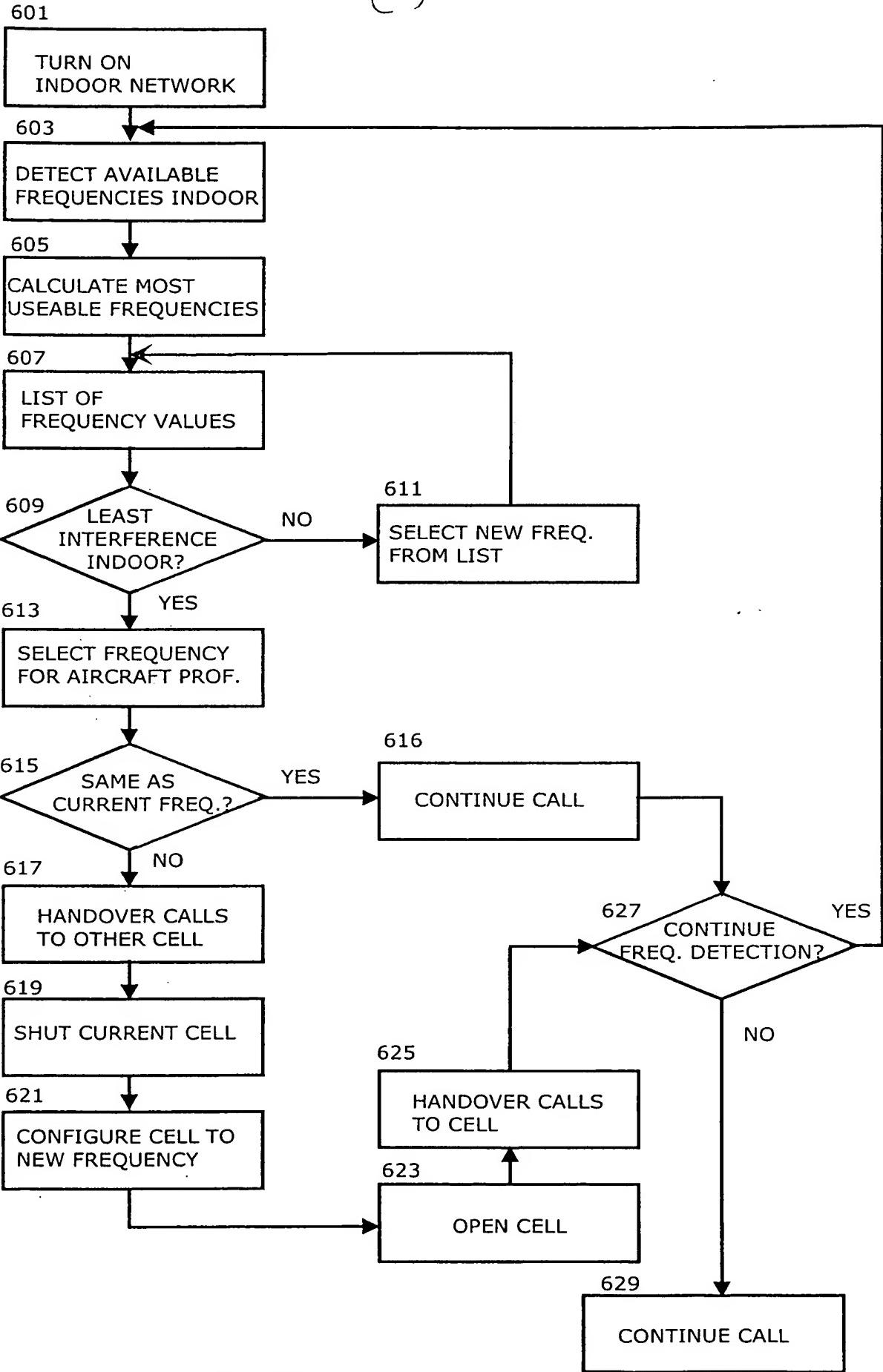
**Fig 4.**

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**Fig 5.**



**Fig 6.**